individual tumor nodule usually has a slowly growing or even stationary center and a more actively growing periphery with varying grades of proliferative activity in between. It is not very practical, therefore, to express the grades of malignancy on a mathematical basis, but it is possible by taking into account the clinical as well as the histological picture to classify them roughly under the headings: very malignant, moderately malignant, relatively benign, and benign.

TRAUMATIC THROMBOSIS OF THE UPPER EXTREMITIES*

By JOSEPH K. SWINDT, M. D.

Pomona

DISCUSSION *by C. Latimer Callander, M. D., San Francisco; Harlan Shoemaker, M. D., Los Angeles; Charles T. Sturgeon, M. D., Los Angeles.*

AN acute thrombosis of the subclavian and axillary veins subsequent to effort has been recognized for forty years, but comparatively few cases have been placed on record. As there have been no autopsies and only a few biopsies, the establishment of indirect traumatism as the causative factor has been left to a forensic discussion of the unsettled theories of thrombus formation in general.

A survey of the literature reveals about fifty cases which have followed unaccustomed activity of the arms. The composite picture which they present is so distinct that the recognition of traumatic thrombosis as a definite clinical entity seems to be fully justified.

A typical case is characterized by Lowenstein as follows: "Following slight or more marked exertion, but without direct injury to the vein, there is a progressive swelling of the arm with pain usually referred to the axilla. With the increase of edema there are evidences of collateral circulation, and cyanosis is of frequent occurrence, although pallor may be present. Palpation of the axilla reveals a hard indurated cord, sensitive to pressure. The development of these phenomena usually occurs without fever and is succeeded by a period of rapid or more often tardy retrogression. This summarizes the history of a typical case of 'thrombose par effort,' 'a spontaneous thrombosis following exertion.'

The effort which produces this type of thrombosis seems to be, in the first place, an oft-repeated or prolonged exertion and, in the second place, one to which the patient is unaccustomed. In this way a sort of chronic trauma is applied indirectly to the vein which is quite different from the acute trauma of contusions and fractures which is applied directly to the vein. Willan's three cases were in athletic men who engaged in heavy labor; Scheppelmann's patient was riding a wild horse; Baum's case was a housewife who had been moving heavy furniture; Rosenthal's were in a woman beating clothes and a child playing ball; Lowenstein's patient carried heavy trays for two hours while waiting on tables; Winterstein's was a weaver who piled heavy bolts of cloth on shelves above his head. My case occurred in a muscular young man "pulling tents" with a citrus fumigating gang. These tents are lifted from the trees by means of long poles and the effort required is extreme, with the arms held high above the head.

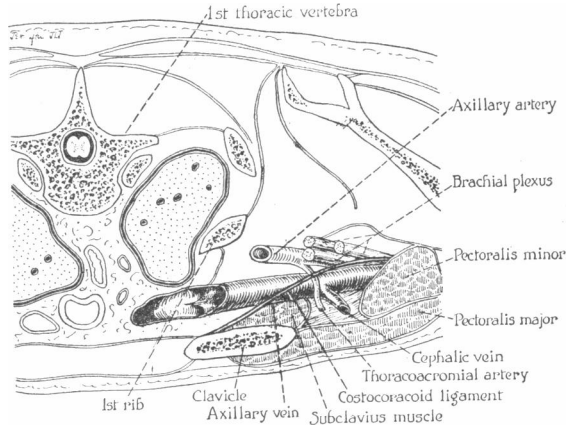

Fig. 1—Upper surface of transverse section at the level of first thoracic vertebra (lower third). Male adult. (Lowenstein.)

The majority of the cases reported have occurred in members of the working class in pursuance of their regular occupation, but called upon to perform some unusual duty, as in the case of the foreman of the tent-pullers taking the place of a sick laborer, or the weaver compelled to hastily pile the heavy bolts of cloth. Certain predisposing factors, such as substernal goiter, intrathoracic aneurysm or tumor, tuberculosis, syphilis, other chronic and acute infections may be present. Regardless of the presence of such predisposing factors it appears that chronic trauma is not incidental but absolutely essential to the production of the variety of thrombosis under consideration. It therefore follows that insofar as the trauma is the result of industrial activity, in all fairness to the injured employee, the lesion should be classed as an industrial accident and as such it should fall within the coverage of industrial compensation.

RÔLE OF INFECTION

Infection has so long been fixed in the minds of the profession as the primary cause of thrombosis that it is difficult to controvert the opinion of Lacene that the lesion is to be explained on the basis of a latent thrombophlebitis of bacterial origin. Most of the cases of thrombosis through effort have not been initiated by chills, their course has not been attended by fever, there has not been leukocytosis and other evidence of infection, and in many instances negative blood cultures have been reported. While Grimalt removed a clot from between ligatures and recovered staphylococcus albus and streptococcus viridens, Scheppelmann incised a thin-walled axillary vein and delivered an aseptic clot. Twenty years ago Welch said, "The problem whether bacteria have led to thrombosis by first invading the vascular wall and setting up an inflammation is not solved by the mere demonstration of their presence in

* Read before the General Surgery Section, California Medical Association, at its Fifty-Sixth Annual Session, April 25-28, 1927.

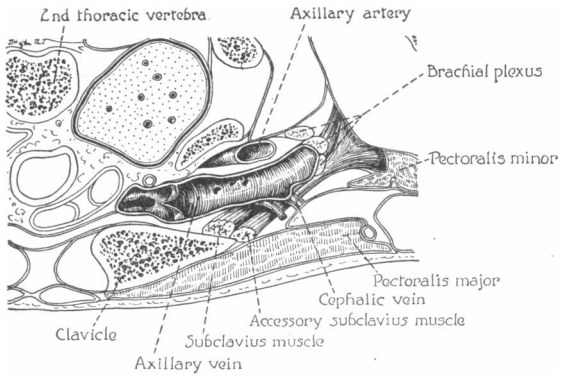

Fig. 2—Under surface of transverse section at level of second thoracic vertebra (upper third). Male adult. (Lowenstein.)

the thrombus." Moreover practically all of the cases of abrupt thrombosis occur in the upper extremity, while it is a well-known fact the thrombophlebitis occurring as a complication of infection practically always is found in the lower extremities.

MECHANICAL THEORY

A study of the various theories of thrombus formation convinces one that traumatic thrombosis may be satisfactorily explained on the basis of Aschoff's mechanical postulates. According to Conner the first comprehensive theory of the etiology of thrombosis was propounded by Hunter and Cruveilhier. They held that the primary condition was phlebitis and the accompanying clot was secondary and incidental. Later Virchow in his classical work on thrombosis and embolism presented a mass of evidence in favor of the view that the thrombosis was the primary and essential process, and that it was brought about chiefly by a slowing of the blood stream from causes which might be either local or general. Then Widal and Vaquez of the French school again shifted opinion to the view that infection plays the most important rôle in the process, and that the primary lesion is inflammation in the vessel wall. In recent years the importance of mechanical factors has again been emphasized in a most convincing manner by Aschoff and the Freiburg school. In mathematical parlance, Aschoff defines thrombosis as "the function of a number of variables" which may arise from three factors, namely, (1) changes in the blood flow, (2) changes in the vessel wall, and (3) changes in the blood elements. Fundamentally these changes are all physical as far as the mechanism of thrombosis as he reproduced it is concerned. The decelerated blood stream, the damaged vessel wall and the agglutinated platelets are essentially mechanical changes. Any one, two, or three of these changes may occur with or without the element of infection.

Welch, who seems to be quoted most frequently by all authors, declares that the factors which govern the slowing of the stream in the veins include "flow from smaller into larger channels, presence of valves, and fixation of the venous wall in certain situations to fascia and bones." The shoulder girdle presents a venous supply which embraces all these factors in a striking combination. Such anatomists as Piersol, Cunningham and Deaver show that the axillary-subclavian vein is a very large and spacious trunk containing one or more valves, receiving several comparatively small collaterals and having a fibrous attachment to the costocoracoid ligament, the clavicle above and sometimes the rib below.

Conner expresses the dictum that "there has been a growing tendency to regard lesions of the intima as of prime importance among the factors concerned in thrombosis." Cadenet concludes that the thrombosis caused by exertion is probably due to a traumatic lesion of the intima determining the coagulation of the blood, and that the circulation is slowed by the forced expiration which accompanies the effort. Rosenthal and Pellow contend that the chronic trauma of muscular effort may "rupture the intima or tear small lateral vessels at the site of the thrombus." When the arm is engaged in severe effort the force of elevated intrathoracic pressure, or expiration, is directed outward through the subclavian vein. The unusual muscular contractions about the veins in the arm direct a peripheral force inward through the axillary vein. The meeting of these opposing forces under the clavicle produces a slowing of the stream at the precise point where the veins present all the anatomic peculiarities which Welch mentions as competent to induce a thrombosis.

ANATOMIC BASIS

In an attempt to discover an anatomic basis for the syndrome of traumatic thrombosis in the upper extremity Lowenstein made dissections of the axilla in thirty cadavers and sagittal sections in six others.[1] In conclusion he says: "It would seem, therefore, that the etiology of thrombosis produced by exertion has a twofold basis: first, ensues a venous stasis or circulatory slowing produced by forced expiration that characterizes effort. This stasis is clearly manifested in the head and neck by cyanosis of the face and the swelling of the jugulars. Secondly, marked abduction (beside the head) or extension (drawing backward) of the arm, probably with lateral rotation, produces a pronounced pressure by the costocoracoid ligament on the axillary vein, with resultant changes in the vascular endothelium sufficient to cause a thrombosis."

The subsequent fate of a thrombus according to Boyd is either absorption or organization. Usually contraction of the fibrin shrinks the thrombus away from the vessel wall, vascular endothelium covers it and the lumen is re-established. Occasionally the blood tunnels through the thrombus which thus becomes canalized. If the lumen is not re-established in these ways the collateral circulation must, through activity, enlarge sufficiently to carry the return flow around the obstruction. A venous thrombus is usually firmly attached to the vessel wall and consequently embolism is rare. The only case of embolism appearing in the literature on traumatic thrombosis is reported by Scheppelmann and followed his attempt at surgical cure of the throm-

bus. Welch says that organization is often well under way in a week and well advanced in two or three weeks.

The treatment of thrombosis in the upper extremities therefore consists of primary rest with the arm elevated for a period of one to three weeks to hasten absorption or canalization. After this massage and elevation are used to encourage collateral circulation. Surgical attack is advised against by all authors, as incision to remove the clot does not prevent the reformation of the thrombus and excision of the vein does not restore the circulation, while either procedure invites pulmonary embolism.

The prognosis as to life is good; as to restoration of function is fair. In a majority of the cases the arm is useful in two or three months, but there remains a certain amount of weakness due to chronic edema which constitutes a more or less permanent partial disability.

CASE REPORT

E. K., workman, age 23, weight 150 pounds. Last confined to bed by scarlatina at age of 11. In January, 1926, had a light cold followed by some transient pains about the thorax, but did not cease work. There have been no signs of respiratory or other infections since. No abrasions or wounds of the hands or arms.

About 3 a. m., August 5, 1926, while overseeing a gang of citrus fumigators patient took the place of one of the tent-pullers who was taken ill. In order to finish the job he worked with unusual vigor pulling the tents from the trees by lifting them at the end of a ten-foot pole, exerting himself to the utmost with the right arm elevated above the head. At the end of an hour he noticed that his right arm was swollen until the shirt sleeve was tight about it. There was numbness in the arm and tingling in the fingers and the weight of the member became oppressive.

During the next ten days the entire arm and shoulder continued to increase in size with some daily fluctuation of tenseness. About August 15 the arm and hand were so tense with swelling that they were painful and he first consulted Dr. John B. Craig of Upland.

Doctor Craig's examination on August 19, 1926, showed that the right arm was four inches larger than the left at the middle of the biceps. The veins about the shoulder were distended, the pressure in the right 140 and the left 125. Temperature and pulse normal. Chest was negative on physical examination and stereoscopic radiograms revealed no bony defects in the shoulder girdle, no goiter or other intrathoracic tumor and normal heart, vessels, diaphragm and lungs. Diagnosis of traumatic thrombosis of the subclavian vein was made.

September 9, 1926, when I first saw the patient, the right arm was three inches larger than the left. The edema about the shoulder extended backward over the scapula and forward to the nipple. There was no swelling in the neck. The veins under the clavicle were greatly distended, and a cord was palpable in the axilla and down the arm to the middle of the biceps. The pulse was equal in both wrists and the blood pressure in the right arm was 140 and in the left 120. There was no adenitis. Blood examination: red blood cells, 4,700,000; white blood cells, 7000; polymorphonuclears, 54 per cent; mononuclears, 30 per cent. Wassermann negative. Urinalysis negative. Pulse and temperature normal.

The patient was put to bed for a few days with the arm elevated above the head and maintained in this position by a balanced weight and pulley. After this he was allowed about in the daytime, using the arm lightly, and keeping it elevated at night, for about three weeks. Gradually the edema and the distension

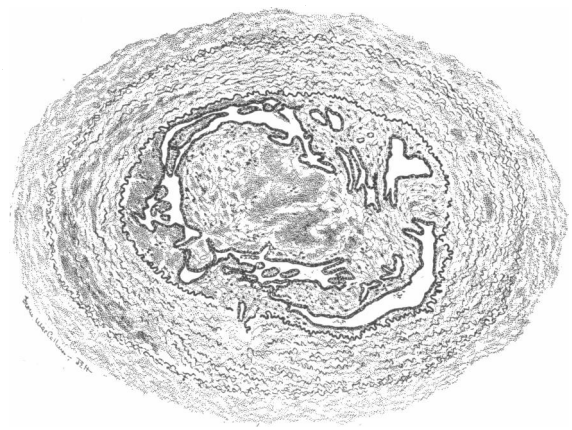

Fig. 3—Organized thrombosis in a vessel canalized by clefts relined with endothelium (MacCallum).

in the collateral veins has become less marked indicating that the lumen of the subclavian vein is being restored. January 15, 1927, the right arm measures only one inch larger than the left, and the pressure is 120 against 115 in the left. He has returned to ordinary farm labor, but often has to resort to elevation at night to reduce the swelling following a day's use. There has not been acute pain, but from the first, stiffness, tightness and heaviness in the arm have been the subjective symptoms.

REFERENCE

1. P. S. Lowenstein: Thrombosis of the Axillary Vein, J. A. M. A., 82; 854, 1924.

DISCUSSION

C. Latimer Callander, M. D. (240 Stockton Street, San Francisco)—I am delighted to have the opportunity of discussing Doctor Swindt's admirable paper on this, one of the rarer varieties of thrombosis, partly for the chance it affords me to congratulate the author on his splendid presentation of the subject, and also for the chance it gives briefly to mention two cases of a similar sort which have come to my attention within the past two years.

Each of these lesions arose in young men following exceedingly violent and sustained work. Both occurred in the upper extremity. One man felt the pain which initiated the thrombosis after prolonged hammering in a strained position with his arm above his head. The other had his onset in connection with continuous pulling at a wire cable in line of his duty about an oil derrick. In each instance there was pain in the upper extremity, particularly about the shoulder, and the sense of weight in the arm was severe and of considerable duration. The swelling and tenseness of the arms and forearms persisted until a complete collateral circulation about the basilic and cephalic networks of veins became established.

As the arms decreased in size the strength gradually returned, although I am unable to state whether total restoration of power occurred with the return of the size of the extremities to normalcy. While these patients remained under my observation most of the blood of the extremities was returning by the collateral paths, an indication that in the several months since onset the deep thrombosed veins had not become canalized.

The conditions of each of these men was considered compensable, but I do not know the degree of permanent disability rating, if any, that each injury imposed. The return of power and the diminution of the edema noted during the period of observation justified the opinion that no permanent disability judgment would be necessary.

❋

Harlan Shoemaker, M. D. (521 Bank of Italy Building, Los Angeles)—Doctor Swindt's paper brings up

the subject of thrombophlebitis. It is very much up to date and gives one an opportunity to speculate on this very academic question.

If we knew more of the processes of life itself, we should then be able to tell exactly what produced thrombosis. Thrombosis in the vessels is so unexplainable that it seems an act of God. One individual is so unfortunate as to have coronary artery thrombosis and sudden death ensues. Another suffers thrombosis in the vessels of the leg, and either suffers chronic phlebitis or loses the leg. The part that chemistry plays in thrombosis has never been fully valued. Doctor Swindt's patient undoubtedly had a sufficient quantity of cyanid to have aided materially in the alteration of the chemistry of the blood. He had just relieved a fellow worker overcome from the gas.

The presence of bacteria does not necessarily produce a thrombosis, but the very highly toxic substance of a very complex chemical naturally excreted by these bacteria or produced by their metabolic activity will produce a very prompt thrombosis. That delicate irritating substance that releases the thrombo plastin, which is the foundation of the blood-clot, is still an unknown substance in the domain of physiological chemistry.

From an academic standpoint such a vital substance is very near the life force itself. When we know more what life is blood-clots will disappear.

❋

CHARLES T. STURGEON, M. D. (1136 West Sixth Street, Los Angeles)—I wish to congratulate Doctor Swindt upon the admirable way in which he presented the subject of traumatic thrombosis of the upper extremities.

This is an extremely rare condition, but nevertheless occurs often enough to cause much speculation as to the cause. It is unquestionably true that thrombosis can be caused by trauma without any infection, but as to why this should occur we are very much at loss to explain. As to the treatment, I believe the conservative treatment is the best. Occasionally a thrombus can be removed successfully, but surgery should not be attempted unless conservative treatment has failed.

The Child's Chance—In the days of Queen Anne of England it was unusual for a baby to live. Of seventeen children that were born to the queen herself only one survived more than a year.

That was centuries back, but infant mortality declined comparatively slowly until a few decades ago.

Birth rates had to be high if nations were not to have a stationary or diminishing population.

Of every 1000 babies born in the United States now only 66 die at birth.

Medical education is the answer. Physicians know more and know how to apply their knowledge. Parents are better informed. So the average age span lengthens.

In Kansas City last year 3000 volunteer workers cooperated with the local children's bureau in a campaign to improve juvenile health. Forty-nine thousand two hundred and eighteen visits were made in 26,803 homes. Treatment for defects was given in 10,216 cases. Letters of advice were sent to the mothers of 4434 new-born babies and the bureau's dietitian made 4790 personal talks on infant feeding.

That is an index to efforts in hundreds of localities.

The conquest of disease and the banishment of ignorance and superstition have become cooperative responsibilities. Such undertakings no longer are regarded as an intrusion into private affairs.

More mothers keep their children, are happy in their possession, and are less anxious as to the menace of sickness. These are not the least of the comforts of the twentieth century.—*Collier's Weekly.*

VISION IN RELATION TO INDUSTRY*

By E. M. NEHER, M. D.
Salt Lake City, Utah

THE condition of the eyesight of employees is the most important factor affecting the output of the industries of our country. Until very recently it has received little consideration other than tests for the acuity of vision and color blindness by the railroads and a few of the larger manufacturers. Those corporations that recognize their duty in determining and conserving the vision of the employees not only become contributors to the health and upbuilding of society, but find production increased, the quality of workmanship improved, less material wasted, fewer accidents occurring, greater individual effort made possible and, above all, a better morale, greater comfort and happiness among the employees when off duty and when at work.

Physicians and an increasing number of employers are unanimous in the opinion that the eyesight of the workmen should be conserved, but it is difficult to find a satisfactory method of accomplishing this. In my opinion the methods should include: (1) Legislation. (2) Vision testing and proper correction of defects. (3) Protection of eyes against injuries. (4) Education.

LEGISLATION

Intelligent legislation—fair to both employee and employer—is the primary factor in inaugurating safety measures. This is accomplished best by establishing an industrial commission which shall be given full power to require the necessary accident reports, to make and enforce safety measures, and to administer equitable compensation, rather than to wait on the slow wheels of a political legislature which meets once in two years.

VISION STATISTICS

Proper eye examinations should be made of new employees and frequent re-examination of old ones. Systematic testing of vision has not been generally done, as is shown by the most accurate statistics I was able to obtain. The Eyesight Conservation Council of America sent inquiries to a selected list of 750 companies and commercial establishments having a safety and a welfare department. Replies were received from 250 companies some of which were too meager to be useful, and only 170 reports that could be analyzed. Of this number ninety-five companies stated eye tests were given, but only twenty-one companies reported periodic examination. Forty companies, representing twenty different kinds of industries, located in various parts of the United States, gave the result of eye examinations of 204,817 employees. The tests used ranged from the most superficial to the more thorough, with an average of 44.3 per cent with defective vision. The Buick Motor Car Company found that 56 per cent of applicants for employment have subnormal vision, while 48.5 per cent of the 60,000 Ford employees

* Read before the Pacific Coast Oto-Ophthalmological Society, Spokane, June 6-8, 1927.